
Institute of Plant Industry,

INDORE,

Central India

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PROGRESS REPORT

for the Year Ending 30th June 1934.

EXAMINER PRESS, BOMBAY.

- (a) The investigation of all matters relating to the production and improvement of raw cotton in India.
- (b) The agricultural development of the Indian States which are members of the Society.
- (c) The training of officers and cultivators nominated by such States.
- (d) The training of advanced students nominated by the Indian Central Cotton Committee.

Its funds are derived entirely from subscriptions. In the year under review the Indian Central Cotton Committee made a grant of Rs. 1,00,000 and the member States in Central India and Rajputana subscribed Rs. 53,000.

The Institute is subsidised by the Indian Central Cotton Committee primarily in order that it may act as a central research station for the elucidation of botanical and agronomic problems of cotton of too wide a nature to be attacked by *ad hoc* schemes. The Indian Central Cotton Committee has also a secondary interest in the Institute in its work for the improvement of variety and cultivation conditions of cotton in Central India.

The interests of the member States lie in the investigation of the specific crop problems of their own territory, and in the development and dissemination of better seeds and more efficient agricultural practices.

The interests of the Indian Central Cotton Committee and of the member states are complementary, and provide a very satisfactory balance to the work of the institute.

The Governing Body of the Institute is representative of the Cotton Committee and the member-States and its President is the Agent to the Governor-General in Central India, *ex-officio*. The Director of the Institute is also Agricultural Adviser to States in Central India and Rajputana, and in addition represents all those States upon the Indian Central Cotton Committee.

CONTENTS.

Administrative and General	Page
1. Board of Governors' Meeting	1
2. Contributing Members of the Institute	1
3. Staff and Students	2
4. Visitors	2
5. Library	4
 Research Work	
6. Organization	5
7. Weather and its effect on crops	5
8. Cotton:	6
(i) Botanical and Genetical	6
(ii) Physiology and Agronomy	12
9. Sugar-cane and Sugar-beet	15
10. Tobacco	16
11. Wheat	16
12. Gram	17
13. Linseed	17
14. Barley	17
15. Jowar	17
16. Lucerne	17
17. Ground-nuts	17
18. Soya-beans	18
19. Rice	18
20. Fibre crops	18
21. Other crops	18
22. General Agronomy	18
23. Pasture survey and manuring	20
24. Silage	21
25. Compost manufacture	21
26. Experimental Technique	21
27. Publications	22
 The Working of the Farm	
28. Weather	22
29. Crops	23
30. Silage	26
31. Compost	26
32. Returns	27
33. Livestock	27
34. Workshop	27
35. Supply of seed and implements	27
36. Maintenance & Improvement	27
37. Experimental work	27
 Propaganda & Extension Work in States	
38. Visits to States	28
39. Instructional and training facilities	28
Conclusion	29
Staff on June 30th 1934.	30

INSTITUTE OF PLANT INDUSTRY, INDORE, CENTRAL INDIA.

PROGRESS REPORT FOR THE YEAR ENDING
JUNE 30TH, 1934.

ADMINISTRATIVE AND GENERAL.

1. Board of Governors' Meeting.—

The Board of Governors met on December 20th, 1933. The report for the year ending 30th June, 1933, was considered, together with a supplementary note on progress up to November 30th, 1933, and the programme for the year 1933-34 was discussed and approved.

2. Contributing Members of the Institute.—

During the year Alwar State has become a member of the Institute, and it is satisfactory to record that the State immediately obtained the services of one of the Institute's research students for one year in order that there might be no delay in initiating the work of agricultural improvement.

At the closing date of this report the following twenty one States in Central India and Rajputana were members of the Institute, arranged in order of joining :

Indore
Dhar
Jaora
Datia
Rutlam
Dewas (Senior Branch).
Sitamau
Narsingarh
Tonk
Bijawar
Barwani
Jhalawar
Bikaner
Rewa
Jaipur
Bundi
Partabgarh
Orehha
Bharatpur
Jodhpur
Alwar

Financial stringency, which causes hesitation over new expenditure, however desirable, still prevents a number of other States from becoming members.

3. Staff and Students.—

Mr. J. B. Hutchinson, M.A., took up his appointment as Geneticist and Botanist on August 24th, 1933.

The Board of Governors sanctioned the creation of two new posts in the Genetics and Botany section, those of Statistical Assistant and Genetical Assistant. The former was filled by the transfer of Mr. V. G. Panse from the post of Chemical Assistant. The latter was filled by the appointment of Mr. Bholanath on the expiry of his Research Scholarship from the Indian Central Cotton Committee on June 1st.

The post of Senior Botanical Assistant is advertised, and will be filled shortly. The post of Chemical Assistant remains vacant at present.

Mr. Phadke, Junior Farm Assistant, remained on deputation to Bharatpur State as Agricultural Officer throughout the year.

4. Visitors.—

The following were among the visitors to the Institute during the year:—
Apte, M. S., Captain, Gwalior.

Awasia, Motilal, Dewan, Sitamau State, C. I.

Azizuddin Ahmad Sir, Prime Minister, Datia State, C. I.

Beckwit F. S., U. C. C. Mission, Indore.

Bhawar, Singh, Kunwar of Kathiwara.

Bingley, B. R., Registrar Cooperative Societies, Holkar State, Indore.

Cains, J. F.

Chaturbhuj, C. G., Treasury Officer, Dewas Junior.

Davis, D., Irrigation Engineer, Holkar State, Indore.

Dabral, B. M., Cotton Physiologist, Agricultural Research Station, Sakrand.

Dhanda, H. L., Manager, Indore Electrical Supply, Indore.

Dyer, J. F., C.I.E., I.C.S., President, State Council, Bhopal, C. I.

Fateh Singh, Rao Sahib, Jailor, Central Jail, Ajmer.

Fitze, K.S., C.I.E., I.C.S., Political Agent in Malwa, Indore.

Fleming, R., Secretary, Lancashire Cotton Enquiry Committee.

Govindram, Seth, Finance Member, Jaora State, C. I.

Grant, Rev. C. F., U.C.C. Mission, Banswara.

Guru Prasad, B.A., LL.B., Industries Minister, Rewa State.

Hari Mohan, Private Secretary to H. H. Jhalawar State, Rajputana.

Hiralal Kalyanmal, Rai Bahadur, Indore.

Hudson, Dr. P. S., Deputy Director, Imperial Bureau of Plant Genetics, Cambridge.

Jackson, Sir R. H., Chairman, Lancashire Cotton Enquiry Committee.

Jagdish Singh, Thakur, M.A., LL.B., Dewan, Narsingarh State, C. I.

Jawalkar, B. L., Land Records Officer, Dewas Junior.

Jha, M. S., Zamindar, Aligarh U. P.

Kanungo, S. V., Finance Minister, Holkar State, Indore.

Kasturbhai Lalbhai, Seth, Ahmedabad.

Keyes, Brigadier General Sir Terence, K.C.S.I. Adviser to H. H. Gwalior.

Khandekar, R. K., Prof. of Literature, Ferguson College, Poona.

Kibe, S. M., Sardar, Holkar State, Indore.

Kothari, G. R., Rao Bahadur, Member, Indian Central Cotton Committee, Berar.

Krall, H., Prof. of Chemistry, Agra College, Agra.

Kulkarni, V. D., Pleader, Belgaum.

Kulkarni, G. D., Chief Secretary, Ichalkaranji (Deccan).

Likhite, Dr. V. N., Dept. of Agriculture, Baroda State.

Macmillan, Rev. J., U. C. C. Mission, Bagli.

Macnabb, The Hon'ble Lt. Col. R. J., I. A., Agent to the Governor General in Central India. The Residency, Indore.

Madgaonkar, Sir Govind, Adviser to H. H. the Maharaja Holkar, Indore.

Mahipal Singh, Raja of Sarila.

Mehta, Chunnilal, Member Board of Governors, I. P. I. Bombay.

Mulk Raj, Chief Revenue Officer, Dhar State, C. I.

Murari, L. T., Livestock Research Station, Hosur.

Nadkar, K., Dewan Bahadur, Dewan & President of Council, Dhar.

Pandey, B. P., Major, B.A., LL.B., Dewan, Orchha State, C. I.

Parkhi, T. V., B.Sc., Court of Wards, Gwalior.

Rama Reddi, P. H., M. A., B. Sc., I. A. S., Secretary, Indian Central Cotton Committee, Bombay.

Rode, K. P., Prof. Benares Hindu University, Benares.

Roy, N. N., Member Council, Rutlam.

Runciman, Rev., Udaipur.

Runciman, Mrs.

Sampatkumaran, M. A., Professor of Botany, University of Mysore, Central College, Bangalore.

Shargha, H. K., B.A., LL.B., Kamdar, Gaurihar, C. I.

Shukla, R. S., Revenue Commissioner, Orchha State.

Taylor, Dr. J. T., U. C. C. Mission, Indore.

Taylor, Dr. A. C., U. C. C. Mission, Rutlam, C. I.

Trench, C. G. C., C.I.E., C.S., Settlement Commissioner and Revenue Commissioner, Udaipur, Rajputana.

Trench, Mrs. Udaipur.

Watson, J. C., Christian College, Indore.

Whitburn, T., Tikamgarh, Orchha State.

Wills, C. O. U., Special Officer, Jaipur State.

Wylie, F. V., Prime Minister, Alwar State.

5. Library.—

Accessions during 1933-34.

Text-books & Works of reference	..	..	..	..	67
Volumes of Journals	..	..	..	..	177
Reports and Bulletins	..	..	..	..	430
Total accessions	..	..	..	..	674

Four new Journals have been added to the list of periodicals taken in the Library.

Classification of the Library material according to the Universal Decimal System followed by the Imperial Agricultural Bureaux is in progress.

One hundred and fourteen periodicals were lent to other Research Workers in India. Applications for loans amounting to about 120 publications; including translations from foreign languages, were made from outside institutions.

A large number of Institute publications have been circulated to member-States, Indian Provincial Departments and foreign Agricultural

Experiment Stations and Institutions. Attached to the Library is a small book depot of standard works on Indian Agriculture. During the year under report 859 books and Institute Bulletins were sold and 2594 are in stock.

Research Work.

6. Organization.—

During the year the expansion noted in last year's Progress Report has continued. A small greenhouse has been erected for the Genetics and Botany section to enable genetic and plant breeding work on cotton to be speeded up by growing two generations a year. Extra laboratory bench space is being provided, a considerable quantity of new research equipment has been added and store room accommodation rearranged, to facilitate the execution of the expanded experimental programme.

The appointment of a Statistical Assistant has led to improvement in the guidance of experimental work in States, and is making possible an investigation into the potentialities of regional co-ordination of field trials. Such co-ordination is expected to provide immediate benefit to the States in the shape of results of greater reliability and wider application, while the development of more accurate methods of regional testing of cotton varieties will be of value to cotton workers throughout India.

It is fitting to acknowledge here the willing co-operation both of the Darbars, and of the officers and voluntary workers concerned, of the various States who undertook to carry out these field experiments. Valuable results have been achieved, and little or none of this important work could have been done without their willing co-operation.

Acknowledgment is also due to the Provincial Agricultural Departments notably those of Bombay, the United Provinces, the Central Provinces and the Punjab for much assistance and co-operation willingly rendered; also to Agricultural Departments in the U. S. A.; Canada, Australia, South Africa, Uganda, Nyasaland and Morocco, and to officers of the Empire Cotton Growing Corporation.

7. Weather and its effect on crops.—

For the third year in succession the monsoon rains were in excess. They broke on June 18th and thereafter in Malwa their distribution was much too continuous for the well-being of the *kharif* crops. Cotton suffered much, though not quite so badly as in 1931 and 1932. In most parts of Rajputana and in the Nimar tract of Central India, however, excellent crops were the rule.

Rabi crops promised to be good but considerable damage was done by frost in mid January. Tobacco was almost completely destroyed and gram suffered heavily in many places. Wheat escaped serious damage in most districts.

8. Cotton.—

(1) Botanical & Genetical.

(a) The creation of a superior strain of *barani* (rain-watered) *Malvensis* cotton for the Malwa plateau has been in progress since 1925, and has now reached the stage of multiplication and distribution. The work of the year under review eliminated three of the five types retained for further test last year. Of these one has been distributed for the 1934-35 season, and the other is being further propagated for distribution later. On the average of ten fully replicated trials carried out in the Malwa plateau, these two strains yielded 20 percent more kapas than the local controls, and one of the two strains ginned 32 per cent and the other 29 per cent as against 28 percent from the local. The mean maximum halo lengths of these types are 23 and 21 m.m. respectively. In four spinning tests the best of these two types has averaged 15's as against 12's from the local.

Examination of the variances of individual components of yield and quality in these strains revealed the fact that although they are well up to the ordinary plant breeding conception of a pure line, they retain sufficient variability to serve as a basis for further selection. In the design of the seed distribution scheme, the maintenance of the pure nucleus stock has been so arranged that further selection can be exercised at the same time, and an investigation prosecuted into the effects of selection on individual components of yield and quality in material of relatively low variability. For this investigation it has been essential to improve the methods of comparing plant breeding material. As an experimental measure, therefore, the progeny rows for 1934-35 have been laid out in randomised blocks of very small plots.

In the course of tours during the 1933-34 cotton season, fresh selections were made from cultivator's fields of cotton in five States in the black cotton soil area, four in the lighter soil areas of Rajputana and two in the Nerbudda valley (Nimar). These were examined at the Institute and the best of them will be grown in the coming season either at the Institute or with the assistance of a State Department in the Nimar tract. An attempt is being made to speed up the acquisition of information concerning these strains also by replication and randomisation in the initial stages.

Multiplication plots were grown on cultivator's land at a very thin seed rate, in order to obtain the maximum increase in seed. The crop was consequently thin, and rather later than crops at commercial spacings. In spite of these disadvantages and the consequent greater damage suffered from frost, both strains proved exceedingly popular, and not only has it been easy to secure the best cotton land in villages close to the Institute for the coming season's multiplication plots, but the whole of the Institute's stock of mass selected seed has been sold in a single village.

Owing to the popularity of the Institute's seed, it has been possible to take the first step towards establishing a block of pure Malvi cotton in the neighbourhood of the Institute.

(b) **Influence of self-fertilisation on vigour.**—The experiment carried out on this problem in the year under review proved inconclusive, and further enquiry has been postponed pending the propagation of material more suitable for the test. It can be said with confidence, however, that if there is any inter-line hybrid vigour in cotton, it is so small as to be of no practical importance.

(c) **Cotton for irrigated and manured land in Malwa.**—Owing to the extreme difficulty of growing a satisfactory crop of New World cotton at the Institute, progress with Cambodia has been slower than with Malvi. While the selected strains Indore 1 and Indore 25 are undoubtedly superior in quality and uniformity, there is no evidence that they are any better in yield than Dhar bulk Cambodia. Arrangements have been made to carry on work on American cottons in more suitable localities, and fresh selections have been made from Dhar Cambodia Malan and from a Bourbon cotton grown by a private individual last year.

The results reported last year from trials involving a comparison of Malvi and Cambodia cotton on irrigated land cast considerable doubt upon the supposed superiority of Cambodia cotton under such conditions.

As the problem of the maintenance of pure seed in Malwa would be greatly simplified if there were only one type to be maintained, it became of importance to obtain reliable data on the relative return to the cultivator of Malvi and Cambodia cotton under irrigated as well as barani conditions. As a preliminary, samples of desi cotton, and American cotton were picked separately in fields where they were growing as mixtures, and samples of the pure lints together with samples of the mixtures were submitted to spinners and to the Technological Laboratory, Matunga, for valuation. The opinions expressed on the relative values of the samples differed very widely. Experiments have been laid down at four centres in Malwa, in each case on adhan and on barani land, to provide accurate data on the relative yields of American and desi cottons and to provide lint for spinning tests on strictly comparable material, so that reliable data shall be available concerning gross return per acre from the two types.

(d) **In Rajputana,** work on cotton in the Gang Canal Colony of Bikaner State continues to make good progress under the special scheme financed by the Indian Central Cotton Committee, the scientific control of which is entrusted to the Institute.

Mollisoni is now definitely recommended as the safest variety of cotton at present. Cwn. 520 has continued to do as well as Mollisoni, and this year experiments have been laid down to give at the same time further information on the behaviour of this variety under Gang Canal conditions and to bulk it up for distribution if desired next year.

Selections were made last season in the Ganganagar farm bulk Mollisoni and in an American strain from the Punjab known as TT Okara.

Observations made during the year on growth and shedding under Ganganagar conditions have led to the conclusion that most existing varieties have not the most advantageous vegetative structure for Ganganagar conditions, and with a view to making selections of types of desirable morphology, plots of unselected Sind desi and Punjab desi are being grown this year.

Studies in cotton agronomy and nutrition have been continued.

(1) **Sowing date.**—The results obtained last year have been confirmed. May sowing has given the highest yield. In the case of Mollisoni sowing as late as June is possible though very late sown cotton seems to yield rather coarse lint. Presowing irrigation followed by cultivation given to May and June sown crops has not given any significant superiority.

(2) **Irrigation adjustments.**—Mollisoni behaved as it did last year with no significant difference between yields when the range of irrigation varied from 3 to 10. Minimum number of irrigations at all stages of growth induced earlier flush. P. 289 F which responded to 11 and 13 irrigations last year showed no significant differences in yield when the number was varied from 6 to 11. This indicates that it is the distribution of irrigation according to the physiological needs of the crop which matters and not the number of irrigations. The favourable influence of liberal irrigation during the flowering stage and to a certain extent during the early seedling stage, and also the detrimental effect of post-September irrigations have been qualitatively indicated by these experiments. Further experiments on irrigation systems are only likely to be of value if carried out as part of a programme of investigation in cotton physiology.

(3) **Green manuring and cotton:**—Sann (*Crotalaria juncea*) or Guara (*Cyamopsis* sp.) ploughed in is clearly superior to fallow in its effect on the subsequent toria (*Brassica Napus*) and cotton crops. When the green crop is cut at flowering stage and removed, however, cotton after sann is found to fluctuate widely in yield as compared with the steady yields of cotton after guara. This may be ascribed to a greater fluctuation in the stand of the surface rooted sann under Ganganagar soil conditions than the guara crop, leading to uneven distribution of organic matter left behind by the stubble.

(e) In view of the importance of the cotton crop in the Nimar tract, considerable attention was paid to it during the year.

In variety trials, Banilla failed to maintain the promise of the previous year, and it is fairly evident that of existing varieties, roseum strains from either the C. P. or Khandesh will give the highest return to the cultivator. Such strains have been introduced in a part of the tract in the past by the Agricultural Department of Dhar State and the Institute's

cotton census (see below) revealed the fact that Nimar cultivators can, and in many cases, do maintain their stocks of roseum seed in a state of reasonable purity over a period of years.

An inquiry into the history of cotton in Central India conducted in connection with the cotton census revealed the fact that the Nimar tract at one time produced a fine cotton. In view of this fact, and of the probable future requirements of the Indian market, it was decided that a systematic attempt should be made to obtain a cotton suitable for the Nimar tract of considerably better quality than the roseum strains available, or the roseum mixture at present grown.

Two lines of selection were initiated : (1) in desi cotton, and (2) in an acclimatised American cotton occurring as a mixture and known as Malan. These selections will be grown during the coming year in replicated and randomised progeny rows at a suitable centre in the Nimar tract.

(f) The botanical survey of cottons grown in India has been modified in the light of experience, and in view of the fact that a considerable body of evidence accumulated in Trinidad is now available to supplement that obtained at the Institute. An arrangement has been made whereby the botanical classification of Indian cottons will be carried out in collaboration with the Curator of the Herbarium, Royal Botanic Gardens, Calcutta. The cotton herbarium in the Royal Botanic Gardens will be examined at the Institute and it is hoped that the comparison of living plants with an extensive range of herbarium material will enable a classification to be made which will be satisfactory both to the botanist and to the agriculturist. At the same time, the study of the genetics of cotton is now sufficiently well advanced for the requirements of genetic principles also to be adequately met.

A clear distinction should be made between a botanical classification, which serves as a framework within which more detailed classifications must fit, and the detailed classification desired by the agriculturalist for convenience in cataloguing his commercial strains. It is to confusion between these two that the present unsatisfactory state of the taxonomy of *Gossypium* must be ascribed. When the botanical classification has been dealt with, it is proposed to discuss the requirements and possibilities of an agricultural classification in a separate paper.

During the 1933 cotton season an extensive census was carried out on the cotton crops of Malwa and Nimar. This was done with two objects in view. In the first place, it was desired to obtain data which would render possible a satisfactory test of the theory that Malvi cotton has deteriorated as a result of mixture with roseum from Nimar. In the second place information was required on the botanical and genetic constitution of the commercial crop before the introduction of pure, improved strains.

Results of great interest and importance were obtained, and are now being written up. In general it may be said that there is no evidence of recent invasion of Malwa by roseum cottons. Easy transport facilities have existed for a very long period between Malwa and Nimar and it is most probable that the present botanical equilibrium is of long standing. There is a record of the occurrence of plants of the roseum type in high quality Malvi cotton as far back as 1843. There is a sharp line of demarcation formed by the Vindhya range between Malvi and Nimari cottons. Below the Ghats the ratio between Malvi and roseum types is 2 to 7 while above the Ghats it is 6 to 1. In the Ghats the ratio is intermediate.

The most striking observation which emerged from the census was that in Malwa over 60 per cent of all cotton plants are American types of the species *G. Hirsutum*. These are usually, but erroneously, known as Cambodia. Some Cambodia seed was introduced into Malwa by the late Mr. Bernard Coventry, C.I.E., but he himself states that an American cotton known as Marwari cotton existed as a considerable component of the local mixture in Malwa at that time. An upland of rather different type known as Malan, exists to the extent of about 20 per cent in the Nimari mixture also. These cottons are no doubt relics of the introduction made under the auspices of the East India Company in the middle years of last century. It is abundantly clear that in the last fifty years the invasion of Malwa by American cotton has been out of all proportion greater than any possible invasion by roseum types.

Opinions on the spinning value of Malwa American are very conflicting. One well known spinner described the sample shown him as of very little value. Another valued it as capable of spinning 30's, while the Director of the Technological Laboratory, in reporting on a fibre test on the same sample (Fibre Test Report No. 87) gave it as the Spinning Master's opinion that: "The Cambodia by itself would yield an even 30's/34's yarn and perhaps is thus a little too good to mix with the Desi." From the mean hair weight per inch data, the American component, the desi component and the mixture all from the same field were judged capable of spinning the following highest standard warp counts:—

Cotton	H. S. W. C.
American	26
Mixture	27
Desi	21

On this basis, quite clearly there should have been a very marked improvement in the spinning quality of Malvi cotton during the last few decades, as the American types spread through the crop.

Experiments have been laid down in the current season to provide further information on the yield and spinning value of Malwa American

in the hope of reconciling the differences in trade opinions, and determining the probable effect of this component on the quality of Malvi cotton.

It may be remarked in passing that whereas the local mixture of Dhar State was valued on this occasion as good for a highest standard warp count of 27, similar local mixtures in spinning tests have averaged a highest standard warp count of 12 only. It is intended to collect material for submission for test by the Technological Laboratory in an attempt to investigate this discrepancy.

(g) The study of the effects of radiation on cotton seeds has been carried a stage further. A plant derived from an irradiated seed has been discovered in which the chromosome number is greater than the normal. Progenies are being grown with a view to discovering any recessive morphological changes which may have taken place.

(h) Cytological work has been carried on with hybrids between the wild *G. africanum* and cultivated Asiatic cottons, and with the progeny of a sterile plant which occurred in an inter-specific cross. In the former experiment changes in chromosome number have been observed. In the latter, considerable genetic evidence has been accumulated, but the cytological evidence is still incomplete. The work is in progress.

(j) The study of the genetics of lint length and ginning per cent has been included as part of a larger investigation into the inheritance of quantitative characters. Quantitative characters are the only ones of interest to the plant breeder, and the problem of their inheritance is one of the most pressing in modern genetics. Together with the study of quantitative inheritance, studies in methods and effects of selection have been commenced, with a view to determining the most rapid and the most efficient methods of obtaining improvement. These experiments involve detailed studies under the following heads :—

1. Development and study of statistics of the second and third degrees for the evaluation of genetic variance and of the effects of selection on the amplitude and symmetry of distributions.
2. Development of statistical methods for separating the environmental and genetic components of variance.
3. Correlation between simple characters and complex ones, and the evaluation of linkage relations of genes of small individual effect.
4. Development of methods of measuring factors influencing quality.

(k) Genetic studies are in progress on the following characters :—

Lintless.
Naked seed.
Anthocyanin pigmentation.
Leaf shape.
Lint colour.
Short petal.
Lethal factors.
Kidney seed.
Crumpled leaf.

Associations between most of these characters and factors for lint quality have already been demonstrated and these experiments afford the data for the study of the linkage relations of genes of small individual effect mentioned above. (1) Studies begun in Trinidad on the nature and causes of genetic instability in certain strains of cotton are being continued, and some evidence has been obtained that the rate of mutation at Indore is of the same order as it is in Trinidad.

(ii) Cotton Physiology and Agronomy.

(a) **Leaf-roll and Red leaf of American cottons.**—It is now definitely established that the conditions produced by deflocculated soil reduce the activity of roots. This lowers the osmotic pressure of the leaf sap. The soil solution appears to become more concentrated due to deflocculation in black cotton soil. Similar soil conditions can also be obtained in naturally open sandy soils, as was observed this year at Jaipur where leaf-roll and red-leaf made their appearance. Further interesting data are expected when the plant material and soils collected are examined. A direct proof of the correctness of these findings was furnished by the successful growth of normal American cotton plants in black cotton soil when open pore space was maintained in the surface layer during the crop season. A paper on osmotic pressure relations was read before the Science Congress 1934.

(b) **Biochemical Studies on Wilt.**—Root studies of healthy and wilted plants in the field indicate that mere presence of fungus in the plant tissue is not enough to cause death. The ratio of active to dead roots in the upper soil zones must become very low, below unity, before the plant succumbs. There appears to be a periodicity in the virulence of the attack which seems to differ from variety to variety. This periodicity is associated with the fluctuations in soil conditions which accompany weather changes. The resulting variations in root vigour lead to the advance of the disease by rapid steps at certain times rather than by steady invasion, and result in a succession of waves of plant mortality. The root distribution of different varieties in soil zones is not always similar and hence adverse conditions in a particular soil zone will not affect all varieties equally. This may explain the differences observed between varieties in the times at which waves of mortality occur. Obvi-

ously a plant with its roots widely distributed both horizontally and vertically is likely to suffer less from the effects of adverse environment in any single soil zone. Such a plant may prove more resistant than one with a localised concentration of roots.

It was observed that the brown discolouration of the root and stem is not always associated with the presence of fungus in the plant tissue. Such discolouration has been artificially produced in cotton plants in water cultures in the absence of fungus.

(c) **Factors governing the yields of cotton.**—The higher yields obtained from pre-rain sown crops varied widely and seemed to depend mainly on the better nutrition of the seedling of the pre-sown crop. Further experiments, while confirming this indicate that the higher yields are not due solely to the interval between two sowings. A paper, embodying these results was read before the Indian Science Congress, 1934.

Root development under presown and rainsown conditions has been studied but the results have not yet been analysed. Sowing in dry soils without irrigation before rains has shown no significant difference over rain sown crops in the case of Desi cotton. There seems to be a tendency for some American cottons to give better yields under these conditions.

(d) **Spacing.**—The great elasticity of the new Malvi selections is confirmed. Spacings of 24" between rows with 8" between plants and 12" between rows with 3" between plants gave no significant difference in yield.

(e) **Topping.**—In fertile soils with vigorous plant growth, topping before the budding stage has a favourable influence on yield. Under poor soil conditions, however, no such influence was found. Later topping had a depressing effect on yield. As a result of these findings certain changes have been made in the morphological standards adopted in selection work.

(f) **Soil Conditions and Yield.**

(1) **Soil Type.**—

In lysimeter experiments with soils of Dhar, Jaipur and Indore carried out at Indore it has been observed that the differences in the yield of cotton both American and desi found in the different tracts, are mainly due to the soil type and not so much to the climate.

(2) **Humus supply.**

Though differences in yields due to surface dressings of various strengths were not significant last year, very large differences in yield were obtained this year when the organic manure was mixed in the whole soil profile. Municipal compost gave better yield than both Farm Yard manure and Farm Compost indicating the importance of phosphatic nutrition to the cotton crop.

(3) Soil Texture.—

In plots where the surface soil was kept open by dressings of lightly heated soil, similar increased yields have been obtained without manuring. It was also observed that the response to manuring is much greater in the soil so treated. It may be noted that in the experiments of 1929-31, surface dressings of super phosphate gave a decreased yield. On examining the profiles of heated soil beds, manured beds and control plots after the cotton crop was harvested, a much more open texture was observed up to about 18" in the former two. It is possible that in garden lands, where organic manure is applied every year, the high yields may be due mainly to the open texture of the soil. Further it is found that better boll development is associated with such increased yields. A paper setting out these facts was read before the Indian Science Congress 1934. A practical application of this finding is being devised this year which if successful will provide a cheap and simple means of increasing cotton yields in the black soils of Malwa.

(4) Artificial manures.—

A preliminary series of pot cultures also indicated that the response of cotton to Nitrogen, Potassium and Phosphorus was profoundly modified by the secondary effect on soil texture of the other components of the ingredients used. This point is being further elaborated both in pot cultures and in fields in different tracts so that the interaction of soil texture and nutrient supply may be more clearly understood. It may then be possible to provide a rational basis for the manuring of cotton under local conditions.

(g) **Crop vigour and seed composition.**—Along with the differences in yield in the same variety of a crop when sown in different tracts or under different conditions in the same tract, differences in the percentage of essential components have been observed. An investigation has now been started to define the nature of this difference and its relation, if any, to the yield vigour of the plant. Groundnut seed is being taken up first for study as it is expected to show clearer differences. This will be followed by studies on cotton, linseed, wheat and barley, typical samples of which have already been collected. The study includes a comparison of the products obtained from healthy and diseased cotton plants as well as the modifying influence of different treatments.

(h) **Reaction changes in the sap as an index to the career of cotton crop.** Previous work reported last year indicated that during the crop period there are periodic fluctuations in the sap reaction which frequently fall below normal. There seems to be a close connection between this periodic ill health of the plant and its final performance. To get a preliminary idea reaction studies have been made on the plant sap as well as on the soil underneath at various stages of growth under different treatments. This work will be further extended in the hope of locating the

most vital period of plant growth, at which existing conditions may determine the nature of its future behaviour. Incidentally the changes in the conditions of different zones of the soil during the crop season in a cotton field will be better understood.

(j) **Ripening of cotton bolls.**—The processes going on during the ripening of the bolls and the influence of environmental factors on them are being studied. This is expected to give clues to the local variations observed in the quality of the produce of varieties.

(k) **Other factors.**—Work in estimating the relative share of sunlight, temperature, and changes in soil atmosphere in producing the several development phases of the cotton plant observed in the field has now been started. A detailed study of the influence of soil atmosphere on healthy and diseased conditions of the cotton plant and the effect of temperature and light on yield vigour as influenced by soil and moisture has been undertaken this year.

9. **Sugar-Cane and Sugar-Beet.**—

It is now definitely established that the growth of Sugarcane till the rains break in Malwa is insignificant and the main development of the crop takes place only in the monsoon. The crop is popular in spite of this handicap and further improvements are being worked out. Co. 290 seems to be a promising variety in Malwa, readily responding to intensive methods, while Co. 213 appears to suit hotter regions and lighter soils. Two leaflets on efficient sugarcane cultivation and gurboling have been issued.

Sugar beet appears to be a substitute for sugarcane in Malwa and similar areas. It has been possible to grow sugar beet as an extensive rain sown crop with little or no manure and yet obtain yields and sugar contents similar to those obtained in bulk crops in Europe. Unlike sugar cane the growing season for beet seems to be longer; the crop stands drought, waterlogging and frost and leaves the soil in deep tilth,, a great advantage for the heavy soils of Malwa, where soil texture is all important in determining yield. A hand slicer has been devised and sun drying of sliced beet on a large scale offered no difficulties. A simple method for the extraction of dried beet, utilising the extract for preparing sugar by a modified Bel process is contemplated. Extensive field trials all over Malwa and Rajputana are being carried out.

It is interesting to note that the Director of Agriculture North West Frontier Province has been successful in cultivating sugar beet over large areas. It is expected that this crop can be grown in many other parts of India with suitable adjustments. The dried sliced beets will be a valuable source of sugar during the off-season, thus removing the handicap of a short operating season, suffered by the cane sugar industry. In addition, beet tops provide succulent fodder in the dry season. Detailed study with a view to early large scale introduction of sugar beet in Malwa and Rajputana has been undertaken.

10. Tobacco.—

Following the successful trials of last year, a large number of varieties suited for hukka, jarda, bright leaf cigarette types, dark heavy leaf for pipe tobacco and cigar wrappers and binders as well as Turkish varieties were grown on a large scale during the year under report. There was no difficulty in growing any of the strains imported from the provinces or from abroad. Turkish tobacco grows well on poor lands and requires least attention. Gujerat varieties succeed very well and their curing has been modified to suit local conditions. The curing of other types also presented no difficulties. With bright leaf imported varieties, however, it was not possible to fix the colour by the modified process, as they are easily affected by weather changes. The Pusa hybrids were easily cured to bright leaf without a flue, but the imported varieties are of better quality and seem to be preferable. A modification to suit the curing of imported types is in contemplation and is expected to be a combination of the process evolved last year with a simplified barn, the latter to be used when weather conditions are unfavourable and probably during the early stages of colour fixing also. If this is successful, the main obstacle in growing cigarette tobaccos will be removed. It is interesting to note that all these tobaccos grow without any irrigation in ordinary wheat lands. Some adjustments in the system of cultivation will have to be made according to the type. The work was greatly handicapped by the wholesale destruction of the crop by frost just at the ripening stage.

Improved methods of economising seed and enabling production of high quality seed have been undertaken. Tobacco trials during the next year will be made on a commercial scale at Indore and other centres.

11. Wheat.—

Previous results—Punjab 8A, Punjab 9D and Pusa 101 are promising types in Rajputana. In Malwa Punjab 9D followed by C. P. 115, Pusa 12 and Pusa 101 have given good yields comparable with local wheat, but the latter is locally recognised as of superior quality. Very high yields of Nimar red, C. P. 115 and P. 101 were obtained in an irrigated trial in Nimar. P. 4, P. 80-5, P. 111 and P. 114 have given Poor yields wherever they were tried.

Results of 1933-34 trials with additional types from Bombay and C.P carried out in 12 States in Central India and Rajputana are being examined.

A comparative investigation of plant development in relation to spacing in durum and bread wheats was carried out in the replicated variety trials at the Institute. The objects of the experiment were to determine the characters having the greatest influence on yield, in order to provide the soundest possible basis for selection, and to compare

the developmental history of Indian varieties with a short life cycle with that of European, long life cycle types. The data collected is of great interest, but the analysis is not yet complete.

Selections were made from local wheats in Malwa Rajputana and Bundelkhand.

12. Gram.—

Previous results—C. P. 28 in Malwa and Punjab 19 in Bikaner have shown promise. Results of new trials with several additional types carried out in 10 states are being examined.

13. Linseed.

Previous results—Cwn. 1206 (seed of pale yellow colour) has given yields approaching local linseed at Indore and in Bikaner. Results of trials with additional types carried out in 9 States are being examined.

14. Barley.—

Previous results—Punjab 4 has given high yields at Jaipur and in Bikaner. It is the best quality barley at present on the market. New trials were carried out at several centres in Rajputana and the results are being examined. Selections were made from the local bulk in Jaipur, Alwar and Datia.

15. Jowar.

Variety trials have been suspended and mass selection work on local jowar wherever it is grown has been started.

16. Lucerne.

Seed imported from Nasik has proved to be the best. As the growth of Lucerne is still not sufficiently vigorous further agronomic adjustments are necessary. Growing on low ridges with indirect watering along furrows seems to give better results. Mixed or associated growth of Sudan grass and Lucerne is being tested in a replicated experiment. A leaflet has been published.

17. Ground-nuts.

Previous results—Gangapuri has given good yields in several trials. At Datia a very high yield of Akola 10 was obtained. New trials with additional American and African types have been laid out in several States.

An attempt to reduce the cost of shelling groundnut seed by sowing whole nuts, slightly cracked or soaked, if necessary, was made during the last two years. Cracked but unsoaked nuts seem to germinate satisfactorily.

18. Soya beans.

Punjab white a promising desi type is being grown in small plots in several States in the coming kharif season.

All the American varieties imported grew satisfactorily at Indore. Their oil content was fairly high and edibility better than desi varieties. The seed is being multiplied for large scale trials before a final choice of variety. The usefulness of the crop as a good fodder and oil seed is still very little known. By production in large quantities in a few centres and growing as a sub-crop in other areas it is hoped to advertise its utility.

19. Rice.

Twenty varieties from Punjab, U. P., Bihar, Bengal and C. P. were tried in garden land as well as in a water logged field. About nine early varieties have stood out in the test, most of them giving a high quality rice. As this crop is intended to be introduced in Adhan lands and as a profitable market exists only for high quality, future work in rice is restricted only to such high class and early varieties. Several modifications in the cropping system are under trial at Indore to increase yield and induce earliness. The most promising varieties have been distributed at several centres in Malwa for trial.

In the water-logged fields only a few varieties reached ripening stage. This point will be investigated in detail during the ensuing year.

20. Fibre Crops.

Sann (*Crotalaria juncea*), Patwa (*Hibiscus cannabinus*) and New Patwa (*Hibiscus sabdariffa*) were compared. A selection of Sann known as Cawn. 12 was tested. So far Sann seems to do best at Indore while at Jodhpur, both patwas were successful. Further large scale trials are in progress.

21. Other Crops.

Early types of tur, such as Malvi and Nimari are being tested in Rajputana.

Improved Punjab, Pusa and Australian varieties of Oats were tried in Bharatpur, Jaipur, Jodhpur and Rewa. Improved Toria, Taramira and Sarson from the Punjab were tried in Rajputana and Bundelkhand. Small experiments were carried out with maize, sesarum, castor, pulses, potatoes and clovers and selections were made from local crops of sesamum.

22. General Agronomy.

(a) **Nitrification in black soils.**—These studies have been carried out in black cotton soils, Jaipur soils and other soil types with and without

manure under summer and rainy conditions, in cropped and uncropped areas and in fertile and poor patches. The various factors operating have been subjected to comparative assay and the bearing of the findings on crop growth is being estimated. Two papers are ready for publication.

(b) **General Soil Studies.**—Surface and sub-soil samples from various localities as well as profile samples from typical tracts are being accumulated with a view to obtaining definite information about the relation between the soil properties and cropping vigour. The differences in the soil depth as regards the mechanical and chemical composition, available nutrients, physical texture, reaction, base exchange and organic matter status will give a definite idea of the normal course of soil behaviour in each tract and is expected to provide a rational basis for determining the nature and practical limits of adjustments calculated to lead to improved soil management. More lysimeters are being constructed for a closer study of the more important soil types on the same model as those of last year, which have proved very useful. Thus a preliminary study of the difficulties of cotton growing experienced during the past season in certain tracts can now be made at Indore in close contact with laboratory work.

(c) **Crop growth in poor patches.**—After preliminary observation during the last few years definite data have now been accumulated in the case of the wheat crop and a detailed study on cotton, Jowar, groundnut and wheat has been undertaken this year. It is expected that the progressive effect of soil texture and moisture movements during the season on the final performance of field crops will be elucidated.

(d) **Water logged soils.**—Adjustments by methods of cultivation having failed during the last season attempts are being made to increase the productive capacity of water logged soils by the introduction of suitable crops and application of chemicals. Similar work has been started at Bharatpur to ameliorate alkali and saline lands. It appears however, that the problem differs only in degree from that of poor patches in ordinary fields.

(e) **Erosion of black cotton soil.**—The severity of losses of fertility due to erosion having been established the importance of reducing them and of maintaining the fertility of the land is as great as that of providing an adequate supply of humus. The main lines of improvement based on the experience of last year are, the use of low spreading crops as contour strip barriers across fields and the planting of low spreading hardy bushes on field margins to retard the rush of sheets of water from outside. Special modifications have to be made to reduce gully erosion. It is expected that a practical method on these lines will be more within the reach of local cultivators than other more elaborate and more costly methods. The progress of this work is bound to be slow but the earlier it is started the better. Wind erosion in the sandy areas of Rajputana is also being kept in view.

(f) **Interculture of crops.**—The relative importance of weeding, shallow and deep interculture was tested on cotton, Jowar and groundnut. The results indicate that the greatest benefit is derived from weeding. Shallow interculture is better than deep probably because the latter leads to greater moisture losses at the ripening stage. Deep, intercultivation, however, in the early wet months is sometimes beneficial. A method of interculture having the advantages of both shallow and deep is in contemplation. Replicated tests for comparing different systems of intercultivation and rotation are being continued.

(g) **Associated growths of crops.**—Sub-cropping Jowar, groundnut and Tur with Soybeans, Cowpeas and black gram was tested in replicated experiments. At the present row spacing (14") the sub crop tends to depress the yields of the main crop. If the main crop can be profitably sown at a greater row distance, it may perhaps be possible to intersow a suitable dwarf non-spreading early variety of Soybeans. This possibility is being investigated.

(h) **Kans eradication.**—Sodium chlorate has been found much more effective than Sodium arsenite but it leaves a certain amount of toxicity behind and a Rabi crop cannot follow immediately. Adjustments to correct this defect and also the possible use of other chemicals is being investigated. A comparative study as regards simplicity and cheapness of chemical methods as against eradication with heavy implements is being made. A revised leaflet on the method of eradication by kans plough has been issued.

(i) **Control of white ants.**—The arsenic bran bait is successful wherever soil moisture conditions are favourable, but in the dry conditions of sandy areas the results have been irregular. Improvements in the method of applications as well as the use of other materials have been undertaken.

(j) **Miscellaneous.**—A variety of plants and shrubs are under preliminary observation, as regards their utility as fodder, cover, green manures, erosion barriers, suitability for saline lands etc. The usefulness of Cowpea as a cover before the rabi crop has been confirmed. Safflower has been grown successfully in Jodhpur with irrigation. Its performance as a dry crop is to be tested.

An agronomical survey to collect together local information about crop environment, systems of cultivation, costs of production and local demand has been started. A questionnaire is being circulated and arrangements have been made for growing several crops in different localities and recording the required costings data.

23. Pasture survey and manuring.

A comparison of feeding values and yield as well as the proportion of edible and non-edible varieties in rich and poor natural pastures has been made. Rich grass areas not only give three times as much bulk of

fodder but also contain fewer of the non-edible weeds which predominate in poor grass land. Application of ammonium sulphate seems to bring poor grass land to the level of rich grass land. Super-phosphate has little or no effect.

24. Silage.

A simple and cheap means of making silage in mudwalled towers from uncut green material including green grass has been devised. A leaflet has been issued and a paper sent for publication.

25. Compost manufacture.

(a) **Farm Refuse.**—Several modifications of the standard process have been devised to suit canal irrigated and rain-fed areas. A bulletin (No. 2, 1934) and two leaflets have been published.

A modification for composting dung alone is under way. This will suit conditions where other materials are scarce. Similar adjustments for composting cane-trash in bulk are in progress.

(b) **Phosphatic Composts.**—The work on composting of habitation wastes was completed with the publication of a bulletin (No. 1, 1934).

Lightly charred bones crushed in a mortar mill have been used in the preparation of compost with rain water. It has been possible to produce composts containing P2 O5 equal to that of pudrette and municipal compost. Work on the preparation of other synthetic composts with high proportions of available plant foods is in progress.

26. Experimental Technique.

Data obtained from the uniformity trial carried out on cotton in 1933 are being examined together with information from scattered plot experiments, and the statistical results of standard trials.

The following information has been obtained from a preliminary examination of the material :—

- (a) An estimate of the effect of discarding outskirts on the accuracy of experiments with different plot sizes.
- (b) An estimate of the value of data obtained by sampling small plots in replicated experiments.
- (c) Determination of the optimum number of samples necessary for halo length determination in cotton.

An attempt is being made to devise a simpler technique for variety trials in outstations which will at the same time provide the accurate information at present obtained from compact replicated experiments. Results from scattered plots in 1933 are encouraging.

27. Publications.

(1) The Sanitary Disposal and Agricultural Utilization of Habitation Wastes by the Indore Process by F. K. Jackson and Y. D. Wad in 'The Indian Medical Gazette' and reprinted as 'Institute Bulletin No. 1.

(2) "The Supply of Humus to Soils" by F. K. Jackson, Y. D. Wad and V. G. Panse in the Empire Cotton Growing Review and reprinted as 'Institute Bulletin No. 2.

(3) 'Nitrogen Balance in Black Cotton Soils in the Malwa Plateau I by Y. D. Wad and V. G. Panse. Indian Journal of Agricultural Science, Oct. 1933.

Institute Leaflets :

No. 3 'Compost manure from Farm Wastes in Canal Irrigated Areas'.

No. 4 'Cultivation of Sugar-cane (on lands not subject to white-ant attack)'.

No. 6. 'Silage making in mud-walled towers.'

The following papers were read at the Jan. 1934 session of the Indian Science Congress at Bombay under

The Genetics of Cotton by J. B. Hutchinson.

Studies in Cotton in Central India and Rajputana.

(1) 'The Influence of manures and the surface texture of black cotton soil upon yields' by Y. D. Wad, S. B. Mogre and V. N. Bhargave.

(2) 'Varietal reaction to date of sowing' by Kubersingh and Y. D. Wad.

(3) 'Osmotic pressure relations between soil solutes and Cambodia. Leaf-Sap' by Y. D. Wad. & S. B. Mogre.

28. The Working of the Farm.

The monsoon started on the 18th June, 1933 and the sowing commenced on the 19th after $3\frac{1}{2}$ inches of rain had fallen. The total rainfall amounted to 50.8 inches. Rainfall decreased from 24th June onwards until 28th after which there was a long break until the 13th July. The latter part of July and the whole of August was a period of heavy rainfall when there was scarcely a rainless day. After a fortnight's break the rain started again on the 14th of September and continued for a week. There was practically no rain in October, except for a fall of 68-cents on the 19th.

29. Crops.

The main kharif crops were cotton, jowar, groundnut, tur, sann and cowpea ; while the rabi crops were wheat, gram, tobacco and beet. Sugar-cane and lucerne were the main irrigated crops.

(a) Cotton.

The area under cotton was 62.75 acres yielding 115 mds. 28 srs. of seed cotton. This gives an average of 148 lbs. per acre of seed cotton for the whole farm, the highest yield being 380 lbs. and the lowest 43 lbs. per acre.

Grouped in the order of their produce the cotton fields stand as under:—

Group I	Field No.	Yield in lbs. per acre.	
	9	380	Above 246 lbs.
	11	289	
	39	262	
	3	256	3 mds.
Group II	1	192	Above 164 lbs. 2 mds.
	4	184	
	43	178	
	40	158	
Group III	44	143	Below 164 lbs. 2 mds.
	7c	121	
	7a	119	
	17	88	
	19	71	
	7b	69	
	5	64	
	16	43	

The heavy and continuous rainfall gave a serious set-back to the crop in its earlier stages, while the frost in January affected the yield of the final picking. It is interesting to note that rich fields like 7a, 7b, 7c, 43 and 44 gave markedly low yields and the comparatively poor fields stood in the first group.

(b) Jowar.

The total area under fodder Jowar was 25.66 acres which yielded 582 mds. giving an average of 22 mds. 40 srs. per acre. The per acre produce from the individual fields was as under:—

Field	Yield in mds. per acre.		
23	56	9	0
22	23	20	0
21	12	26	0
34	11	16	0
8	9	12	0
28	4	26	0

The Jowar was grown mixed with cowpeas in various proportions. The cowpea was suppressed totally and the above figures represent yield of Jowar alone. The effect of heavy rainfall is clearly indicated by the low yields. The first field in the above list is a fairly rich field while the remaining except 22 are water logged more or less. The yield varied directly according to the drainage of the field.

Jowar for grain (local variety) was grown on 7 acres yielding 35 mds. 30 srs. which is about 5 mds. to the acre.

Field No.	Yield in Mds. per acre.
42	9 0 0
45	5 0 0
15	5 10 0

The crop in field 15 was attacked by smut while that in field 45 was damaged by erosion.

Varieties of Jowar were grown, Ramkel giving the highest yield.

(c) Tur.

Nine acres of tur yielded 57-28-0 or an average of 6-16-0 per acre. Arranged in order of their yields, the fields stand as under :—

Field No.	Yield in Mds. per acre.
15	8 30 0
3	7 30 0
41	5 17 0
30	4 10 0

In this case too the yields are affected more by drainage than by fertility (compare cotton).

Varieties of tur were grown, but they suffered heavily from frost.

(d) Sann.

This was grown for composting and for seed. The total area under sann for compost was $11\frac{1}{2}$ acres, which yielded 247 mds. of green material when cut at flowering stage.

The crop for seed yielded 10 mds. 27-0 of *clean* seed from an area of 10 acres. The field was badly infested with a creeping weed known as Pevashi. The seed of this was heavily mixed with sann—nearly $7\frac{1}{2}$ mds. of weed seed was separated and burnt.

The stalks were used for compost.

(e) Groundnuts.

Akola 10, Spanish peanuts, Gangapuri and Malvi were grown. The per acre yields were as under :—

Akola 10	..	..	..	..	4½ mds.
Spanish peanut	..	..	..	..	5 „
Gangapuri	..	..	..	..	12 „
Malvi	..	..	..	..	4¾ „

The last two are late and spreading varieties. Low yield of Spanish peanut was due to the poverty of the field. In the case of Akola 10, the sowing was delayed and was followed by a break in the rains. Much damage to the seed was done by pests. The germination was very poor. Gangapuri and Malvi were grown on a very small scale.

(f) Soybeans.

These were grown on a small scale and in association with cotton, tur and groundnuts.

(g) Wheat.

The total area under wheat was about 51 acres and the yield irrespective of variety, for the whole farm area was 233 mds. or 4 mds.-20 srs.0 per acre, the highest being 8mds. 28srs.-0 and the lowest 3 mds.-20srs-0 per acre. Fields can be grouped according to their yields as under : -

Field No.	Yields in mds. per acre.		
42	8	28	0
30	6	20	0
1	6	6	0
5	5	3	0
15	5	0	0
27	5	0	0
2	4	4	0
16	4	0	0
3	3	27	0
18	3	20	0

Water logged fields gave better yields than well drained fields of moderate depth.

Bansi varieties from Nasik were tried both dry and irrigated. Type 168 is early maturing but its earliness was against it as it is subject to attack by pests. All Bansi varieties ripened earlier than the local Malvi but in yield Malvi stood first.

(h) Gram.

In fields where the cotton was suppressed by heavy rains gram was sown between the cotton lines. Some of it was sold green and some was fed to the farm bullocks. Total area under this crop was 30 acres.

The crop left for grain yielded $3\frac{1}{2}$ mds. to the acre. The low yield was due to frost. Of the varieties grown C. P. 28 and Malvi were early and less attacked by frost. Pusa and Punjab varieties were late and were damaged heavily by frost. The yields have not yet been examined.

(i) Linseed.

E. B. 3 and local Malvi were early. They were less affected by frost as compared with Cawnpore varieties. Cawnpore 1193 was earlier than the others. Among the Pusa types and hybrids, Type 11 was the earliest and suffered the least from frost.

The yields have not yet been compared statistically.

(j) Sugarcane.

Suitable land not being available, sugarcane was grown in shallow barani land. The crop was poor and disappointing.

(k) Tobacco.

All varieties grew well in various fields, irrespective of fertility or irrigation. The crop was excellent but it was destroyed by frost. The dead plants were cut close to the ground immediately, and ratoon growth was obtained.

(l) Sugar-beet.

Two acres of this were grown. The crop was excellent.

30. Silage.

Green grass and fodder jowar were used for making silage, partly in mud towers and partly in pits. 858 mds. of good silage were obtained. That silage can be successfully made in kutchra towers is now confirmed.

31. Compost.

500 cartloads of compost were made from farm waste by the standard Indore method and the rain watered processes.

The composting of habitation wastes from the residential block is in progress.

32. Returns.

The calculated gross returns of the Farm amount to Rs. 7,000. The frost affected the returns considerably.

33. Live Stock.

Now that the work of permanent land improvement is finished the number of bullocks has been reduced from 22 to 14 pairs without in any way affecting the work of the farm. 240 acres of land are under cultivation.

34. Workshop.

The workshop is now well equipped and most of the work for the laboratories was done by the mistry in addition to his work for the farm. Simple laboratory appliances and small machines were made to satisfaction without outside assistance. Considerable quantities of furniture and laboratory equipment were made during the year in an economical manner. Manufacture and repair of farm implements was also carried out. The gin house was also maintained by the mistry and cotton from multiplication plots was ginned in addition to the Farm bulk cotton.

35. Supply of seed and implements.

From the trading stock a number of implements such as bakharas, ridgers, and seed drills, and tools such as drag rakes, and digging forks were sold.

There was a great demand for cotton seed and groundnuts. The stocks available were quite inadequate.

36. Maintenance and Improvement.

Some of the farm area is being washed and eroded by the nullah on the north side. Measures are being taken to remedy this evil. One unused well was repaired and deepened and an area of 3 acres commanded by it brought under irrigation.

37. Experimental Work.

The total number of experiments carried out during the year was 36 out of which 26 were kharif and 10 were rabi.

(a) Kharif crop.—8 permanent experiments are in progress on Rotation, Interculture of Jowar and Cotton, Winter cultivation, Soil erosion, Pasture studies, Kankar eradication and the incorporation of organic matter in the soil.

Of the remaining 18, eight dealt with the association of crops, four are varietal and two are manurial.

(b) Rabi.—Seven were varietal trials and the rest were agronomical.

There were small growth trials of oats, barley, bagilla, berseem, okra and linseed.

In garden crops there were manurial, agronomical and varietal trials on lucerne and sugarcane.

PROPAGANDA & EXTENSION WORK IN STATES.

38. Visits to States.

During the year under report, the Agricultural Adviser made twenty four visits to States, the Extension Officer made thirty-four, the Geneticist and Botanist, six, the Chemist and Agronomist one, and other officers nine.

39. Instructional and training facilities.

Agricultural training was given to agricultural and revenue officers from eight States, students nominated by three States and cultivators sent by one State. In addition, two States sent agricultural officers and cultivators for special training in tobacco work.

With the cooperation of the Indore City and Residency Area Municipal authorities, training in the method of making compost from habitation wastes was given to municipal officers and staff from seven member States, Secunderabad Cantonment authorities and officials of the Ajmer jail.

Assistance was given by the Extension Officer and members of the farm staff in organising demonstration and propaganda work at Agricultural Shows and Cattle Fairs in Seven States : Indore, Datia, Narsingarh, Orchha, Jhalawar, Tonk and Bharatpur. Exhibits illustrating the advantages of pure seeds and improved methods were shown and demonstrations given of simple implements, of compost making and silage making in kutchha towers. Cinematograph films of agricultural subjects were also shown, the films being provided free of charge by the Indian Central Cotton Committee and the Central Railway Publicity Board.

In the course of his tours the Extension Officer gave demonstrations and lectures to gatherings of cultivators in villages, encouraging the use of good seed, initiating the making of compost and silage, and advising on all matters of crop improvement. The students of a mission seminary in Indore visited the farm, and methods of improving agricultural practice were demonstrated to them. A cinema demonstration and lecture was given to them in the seminary by the Extension Officer.

CONCLUSION.

That the value of the Institute's work for the agriculture of Central India and Rajputana is known and appreciated is shown by the interest of member-States and the enquiries from non-members. The policy initiated two years ago of organising field trials on modern lines on State farms and on the lands of enlightened cultivators is already yielding results, and the range of subjects on which the Institute is in a position to offer advice to member States is rapidly extending.

That the research work of the Institute is also known and appreciated is shown by the large and increasing volume of research correspondence received and by the extent of the demand for exchange of the Institute publications. This is particularly satisfactory since the results of research work are only slowly realised.

J. B. HUTCHINSON.

Offg. Director.

STAFF AND RESEARCH STUDENTS OF THE INSTITUTE OF PLANT INDUSTRY ON JUNE 30TH, 1934.

Administrative & Clerical :

Director & Agricultural Adviser to F. Keith Jackson, N. D. A. (Hons.),
States in Central India and Dip. Ag. (Cantab.)
Rajputana.

Personal Assistant	..	A. N. Srivastava, M. Sc.
Head Clerk & Accountant	..	G. M. Nadkarni.
2nd Clerk .. ..	..	Mohiuddin Khan.
3rd Clerk .. ..	..	D. D. Smith.
4th Clerk .. ..	..	S. M. Ajmi.
Artist .. ..	..	S. R. Srinivasan Ayyer.
Assistant Artist .. ..	..	S. Joseph.
Librarian .. ..	..	Bashir Husain Khan.
Experimental Record Clerk	..	S. A. Khargonekar.

Botanical :

Geneticist & Botanist J. B. Hutchinson, M.A. (Cantab).
(Offg. Director in leave vacancy
from March to Sept. 1934.)

Senior Botanical Assistant	..	Vacant.
Plant Breeding Assistant ..	..	Kubersingh, B. Ag.
Botanical Assistant .. ..	..	R. L. M. Ghose, M. Sc.
Statistical Assistant .. ..	..	V. G. Panse, B. Sc.
Genetical Assistant .. ..	..	Bholanath, M. Sc.,
Fieldman .. ..	..	E. L. Rajanna.
Research Student .. ..	..	G. K. Govande, M. Sc., B. Ag.*
„ „ .. ..	..	M. A. Ansari, M. Sc.*
„ „ .. ..	..	P. D. Gadkari, M. Sc.†
„ „ .. ..	..	S. C. Chakravarty, M. Sc.*
„ „ .. ..	..	Shamlal Nayar, M. Sc. §

Chemistry & Agronomy :

Chemist & Agronomist ..	..	Y. D. Wad, M.A., M.Sc., A.I.I.Sc.
Laboratory Assistant ..	..	L. N. Desai, B. Sc.
„ „ ..	..	G. T. Shahane.
„ „ ..	..	V. S. David.

Laboratory Assistant	..	..	R. S. Gharpara, B. Sc.
Research Student	..	..	Chiranjilal Nagar, B.Sc., (on deputation to Alwar State as Agricultural Officer.)
"	"	..	V. N. Bhargave, B. Sc.* (on deputation to Ganganagar as Cotton Assistant).
"	"	..	R. K. Aurangabadkar, M. Sc.*
"	"	..	S. C. Chakravarty, M. Sc.*
"	"	..	K. N. Ambegaonkar, M. Sc.*
"	"	..	T. Krishnamoorthy, B. Sc. (Ag.)*
"	"	..	I. Madhusudan Rao, M. A., M. Sc.
"	"	..	S. B. Mogre, M. Sc.*
"	"	..	B. S. Kochrekar §

Propaganda & Extension Work :

Extension Officer M. L. Saksena, L. Ag. F.I.C.S.,

Farm Executive:

Farm Superintendent G. C. Tambe, B. Ag.

Assistant Farm Superintendent .. S. C. Talesara, B. Ag.

Junior Farm Assistant G. G. Phadke, L. Ag.
(on deputation to Bharatpur State as Agricultural Officer
N. S. Apte, B. Ag. acting.)

" " K. M. Simlote, B. Ag.

" " .. (under training) Lakshman Swaroop, B. Sc. (Ag.) §§

Fieldman Nihalsingh.

" V. R. Sathe.

" G. M. Nigudkar.

Storekeeper Ishri Prasad.

* Institute of Plant Industry Studentship.

† King Edward Memorial Fund Scholarship.

§ Voluntary research worker.

§§ Nominated by Alwar State